3.1
Earth (WAC 463-42-302)

WAC 463-43-302 NATURAL ENVIRONMENT — EARTH.
The applicant shall provide detailed descriptions of the existing environment, project impacts, and mitigation measures for the following:

(1) Geology - The applicant shall include the results of a comprehensive geologic survey showing conditions at the site, the nature of foundation materials, and potential seismic activities.

(2) Soils - The applicant shall describe all procedures to be utilized to minimize erosion and other adverse consequences during the removal of vegetation, excavation of borrow pits, foundations and trenches, disposal of surplus materials, and construction of earth fills. The location of such activities shall be described and the quantities of material shall be indicated.

(3) Topography - The applicant shall include contour maps showing the original topography and any changes likely to occur as a result of energy facility construction and related activities. Contour maps showing proposed shoreline or channel changes shall also be furnished.

(4) Unique physical features - The applicant shall list any unusual or unique geologic or physical features in the project area or areas potentially affected by the project.

(5) Erosion/enlargement of land area (accretion) - The applicant shall identify any potential for erosion, deposition, or change of any land surface, shoreline, beach, or submarine area due to construction activities, placement of permanent or temporary structures, or changes in drainage resulting from construction or placement of facilities associated with construction or operation of the proposed energy project.

3.1 EARTH
(WAC 463-42-302)

The proposed Satsop CT Project is located in Satsop, Grays Harbor County. Existing conditions and potential impacts are discussed below, including evaluation of geology, soils, topography, unique physical features, and erosion/enlargement of the land area. With standard and site-specific mitigation measures, impacts on the natural earth environment from the construction and operation of the Phase II project are expected to be minor (URS 2001).

This section presents information on "Earth" in the following subsections, including information on existing conditions, potential impacts, and where appropriate, mitigation measures.

- Geology (Subsection 3.1.1)
- Seismicity (Subsection 3.1.2)
- Soils (Subsection 3.1.3)
- Topography (Subsection 3.1.4)
- Unique Physical Features (Subsection 3.1.5)
- Erosion/Enlargement of Land Area (Accretion) (Subsection 3.1.6)

3.1.1 GEOLOGY

3.1.1.1 Regional Setting

Western Washington and the adjacent continental margin have been divided into four major tectonic terranes reflecting the regional tectonic setting at the margin of two converging plates. These terranes are the continental margin, the fore-arc, the volcanic arc, and the back-arc. The Satsop site is located within the Willapa Hills tectonic province of the fore-arc (Figure 3.1-1).

The geologic units in the site region consist of Tertiary age sedimentary and volcanic rocks overlain by Quaternary glacial, glaciofluvial, and alluvial deposits (Figures 3.1-2 and 3.1-3). In addition, landslide deposits in the Astoria Formation and Helm Creek deposits have been mapped by Gower and Pease (1965) in the nearby Montesano Quadrangle and were mapped near the site during preparation of the Final Safety Analysis Report (FSAR) for the construction of WNP-3 (WPPSS 1988). The slides are composed of broken, distorted and dislocated parent material and range in areal extent from 0.4 to 40 hectares (1 to 100 acres) (Figure 3.1-3). The largest appear to be located in the Astoria sandstone.

Geologic structures in the site vicinity consist of several broad uplifts, folds, and faults that generally trend northwest (Figure 3.1-3). These structures are interpreted to result from northeast-directed compression caused by convergence of the Juan de Fuca and North American plates during the Tertiary. The shortening of the crust caused by the compression that was taken up by the structures.

Three basement uplifts occur within 20 miles (30 kilometers) of the site: the Minot Peak Uplift, the Blue Mountain Uplift, and the Black Hills Uplift. These uplifts are broad, open domes and typically have faulted margins. The Crescent Formation is often exposed at the core of the uplifts. Faults mapped in the site vicinity include the Gibson Creek and Welkswood Canyon faults. The site is located on the northern nose of a broad, poorly defined anticline that is the northern extension of the Minot Peak Uplift (Figure 3.1-3).

The faults mapped within the site vicinity are interpreted as being associated with the uplifts and are rooted in the Crescent Formation basalts. FSAR field investigations discovered no previously unmapped faults in the site vicinity and no faults cutting the Quaternary deposits such as the Helm Creek (WPPSS 1988). This indicates that the age of the structures is pre-Helm Creek and that these are not considered to be active structures.

3.1.1.2 Plant Site Area

The plant site is situated on a Quaternary river terrace formed on flat-lying Helm Creek glaciofluvial deposits (Figure 3.1-4). The deposits are regionally correlated with other similar deposits dated at 250,000 to 320,000 years old (WPPSS 1988b). The deposits are reworked glacial materials carried downstream by the ancestral Chehalis River. The sediments are fine- to medium-grained sands, silts, and clayey silts. Gravel lenses are locally present and a peat horizon was intercepted in one of the borings completed for the discontinued nuclear project. The deposits range in thickness from 100 to 200 feet (30 to 60 meters).

The Helm Creek deposits lie on Miocene age fine sands and silts of the Astoria Formation (Figure 3.1-4). This marine deposit is 2,500 to 3,000 feet (800 to 900 meters) thick and overlies Lincoln Creek in the regional stratigraphy (Pease and Hoover 1957). The sandstone is thick, bedded to massive, light olive-gray, poorly sorted silty to fine to medium-grained sand (Pease and Hoover 1957). Other rock types included in the Astoria Formation are tuff and tuffaceous sandstone beds 1 to 12 feet thick, thin lenses of siltstone and conglomerate, and seams of carbonaceous material (WPPSS 1988).

Loess, or wind-blown glacial silt, can be found in local accumulations from 5 to 15 feet (1.5 to 5 meters) thick overlying the terrace deposits of the Helm Creek. The thicker loess is found in closed depressions on the site. Recent alluvium and colluvium represent the most recent deposits in the immediate site area. Carbon-14 age dating of charcoal in the deposits have given a date of up to 37,000 years before present (WPPSS 1998). Information on the site-specific subsurface conditions is presented in Subsection 3.1.3.

3.1.2 SEISMICITY

Strong ground motions that could potentially affect the site can be generated from earthquakes on several regional seismic sources. Earthquakes are the result of sudden releases of built-up stress within the tectonic plates that make up the earth's surface. The stresses accumulate because of friction between the plates as they attempt to move past one another. The movement can be between plates such as when one plate moves over another, as in subduction zones or within the plates themselves. Earthquakes in the Pacific Northwest can originate from four different types of seismic sources: (1) interplate earthquakes on the Cascadia Subduction Zone (CSZ) between the Juan de Fuca plate and the overriding North American plate, (2) intraplate earthquakes within the subducting Juan de Fuca plate as it sinks and breaks up, (3) shallow crustal earthquakes on faults within the North American plate, and (4) volcanic earthquakes such as those associated with the eruption of Mount St. Helens. These sources are depicted on Figures 3.1-5 and 3.1-6. The largest historical earthquakes in Washington, southern British Columbia, and northern Oregon are shown on Figure 3.1-7 and summarized in Table 3.1-1.

The historic record of seismicity in the Pacific Northwest (approximately 150 years) is insufficient to indicate whether the CSZ has generated or is capable of generating a great earthquake of magnitude (M8 or greater). This type of event apparently occurs every several hundred years and results in major earthquakes at depths of approximately 6 to 25 miles beneath coastal and offshore Washington. Geologic and geodetic studies during the last 10-plus years indicate that great (M8+) earthquakes have occurred on the CSZ during the Holocene and could occur during the project lifetime (Adams 1996; Atwater 1996, 1987a, 1987b, 1992; Atwater and Hemphill-Haley 1997; Carver and Burke 1987; Darienzo and Peterson 1990, 1987; Grant and McLaren 1987; Peterson and Darienzo 1996; Savage and Lisowski 1991; Nelson and Personious 1996). Geologic evidence for the most recent great earthquake (approximately 300 years before present [b.p.]) has been found at many coastal locations in Washington and Oregon. It is uncertain whether a single earthquake or several separate earthquakes closely spaced in time caused the geologic effects recorded at these locations. However there is a general consensus that the CSZ has generated earthquakes of M8 or larger in the past few thousand years (Atwater et al. 1996; Nelson and Personius 1996; and Weaver and Shedlock 1996).

In the FSAR (WPPSS 1988), theoretical arguments are presented that: (1) the CSZ has three discrete segments, (2) that great earthquakes would be confined within each segment and (3) because of the limited length (less than 300 km) each segment is capable of generating earthquakes of only M8.5 or less. Rogers (1988) and Heaton and Hartzell (1986) suggest that a moment magnitude M9.1 CSZ earthquake could occur that would rupture the entire 900-km length of the Juan de Fuca plate between the Explorer and Gorda plates (offshore from Vancouver Island, British Columbia to northern California near Eureka). Analysis of historical records of tsunamis in Japan support the interpretation that the most recent great earthquake on the CSZ was about M9 (Satake and Tanioka 1996). This type of event would generate long period ground motions for a relatively long duration at the Satsop site.

TABLE 3.1- 1
LARGEST KNOWN EARTHQUAKES FELT IN WASHINGTON[a]

Year	Date	Time (PST)	North Latitude	West Longitude	Depth (km)	Mag (felt)[b]	Mag (inst)[c]	Max. Mod. Mercalli Intensity	Felt Area (sq km)	Location
1872	12-14	2140	48°48'00"	121°24'00"	shallow	7.3	None	IX	1010000	North Cascades
1877[d]	10-12	1353	45°30'00"	122°30'00"	shallow	5.3	None	VII	48000	Portland, Oregon
1880	12-12	2040	47°30'00"	122°30'00"			None	VII		Puget Sound
1891	11-29	1521	48°00'00"	123°30'00"			None	VII		Puget Sound
1893	3-6	1703	45°54'00"	119°24'00"	shallow	4.7	None	VII	21000	Southeastern Washington
1896	1-3	2215	48°30'00"	122°48'00"		5.7	None	VII		Puget Sound
1904	3-16	2020	47°48'00"	123°00'00"		5.3	None	VII	50000	Olympic Peninsula, eastside
1909	1-11	1549	48°42'00"	122°48'00"	deep	6	None	VII	150000	Puget Sound
1915	8-18	605	48°30'00"	121°24'00"		5.6	none	VI	77000	North Cascades
1918[d]	12-6	41	49°37'00"	122°55'00"		7	7	VIII	650000	Vancouver Island
1920	1-23	2309	48°36'00"	123°00'00"		5.5	none	VII	70000	Puget Sound
1932	7-17	2201	47°45'00"	121°50'00"	shallow	5.2	none	VII	41000	Central Cascades
1936	7-15	2308	46°00'00"	118°18'00"	shallow	6.4	5.75	VII	270000	Southeastern Washington
1939	11-12	2346	47°24'00"	122°36'00"	deep	6.2	5.75	VII	200000	Puget Sound
1945	4-29	1216	47°24'00"	121°42'00"		5.9	5.5	VII	128000	Central Cascades
1946	2-14	1918	47°18'00"	122°54'00"	40	6.4	6.3	VII	270000	Puget Sound
1946[d]	6-23	913	49°48'00"	125°18'00"	deep	7.4	7.3	VIII	1096000	Vancouver Island
1949	4-13	1155	47°06'00"	122°42'00"	54	7	7.1	VIII	594000	Puget Sound
1949[d]	8-21	2001	53°37'20"	133°16'20"		7.8	8.1	VIII	2220000	Queen Charlotte Isl., B.C.
1959	8-5	1944	47°48'00"	120°00'00"	35	5.5	5	VI	64000	North Cascades, east side
1959[d]	8-17	2237	44°49'59"	111°05'	10-12	7.6	7.5	X	1586000	Hebgen Lake, Montana
1962[d]	11-5	1936	45°36'30"	122°35'54"	18	5.3	5.5	VII	51000	Portland, Oregon
1965	4-29	728	47°24'00"	122°24'00"	63	6.8	6.5	VIII	500000	Puget Sound
1981	2-13	2209	46°21'01"	122°14'66"	7	5.8	5.5	VII	104000	South Cascades
1983[d]	10-28	606	44°03'29"	113°51'25"	14	7.2	7.3	VII	800000	Borah Peak, Idaho
1990[g]	4-14				3		5.2	VI		Deming
1993[d]	3-25	535	45°02'00"	122°36'26"	16		5.6	VII		Scotts Mills, Oregon
1995[f]	1-29	1511	47°23'24"	121°21'36"	20		5	V		Robinson Pt., Vashon Island
1996[e]	5-02	2104	47°45'36"	121°51'00"	7		5.3			Duvall
1999[e]	7-02	0543	47°'33	123°'49"	41		5.5 – 5.9	VI		Satsop
2001[c]	2-28	1054	47° 9'9"	122° 43'11"	52		6.8	VIII		Nisqually
2001[c]	6-10	0519	47° 9'58"	123 °30'21"	41		5.0	V		Satsop

(a) Data from Noson et al. (1988); EERI (1993) except where noted otherwise

(b) Mag (felt) = an estimate of magnitude, based on felt area; unless otherwise indicated, it is calculated from Mag (felt) = -1.88 + 1.53 log A, where A is the total felt area in km²; from Toppozada (1975).

(c) Mag (inst) = instrumentally determined magnitude; refer to references listed in the original Table 2 of Noson et al. (1988), or (e) below, for magnitude scale used.

(d) Earthquakes with epicenters outside Washington.

(e) Data from University of Washington Geophysics Program via http://www.geophys.washington.edu/seis/.

(f) Dewberry and Crosson (1996)

(g) Dragovich et al. (1997)

Intraplate seismic events result from rupture within the subducted plate at depths of 20 to 55 miles. Based primarily on the historical intraplate earthquakes in western Washington and other subduction zones of the world, the intraplate zone is considered capable of generating earthquakes as large as M7.5. Because intraplate earthquakes do not cause deformation at the ground surface that can be distinguished from other types of earthquakes, the typical frequency of these earthquakes cannot be readily assessed. However, these types of earthquakes have historically caused the greatest amount of damage in western Washington. This source has generated three of the largest historical seismic events to affect the Pacific Northwest, the 1949 Olympia earthquake of magnitude M7.1, the 1965 M6.5 Seattle earthquake, and the 2001 Nisqually M6.8 earthquake. These earthquakes caused substantial damage in central and southern Puget Sound and were strongly felt in Satsop, but damage in the Satsop area was relatively minor (Thorsen 1986; UW 2001). In addition to these large intraplate events, there have been two moderate magnitude (M5.0 to 5.9) events centered in the Satsop area (Table 3.1-1). The July 2, 1999 event (M5.7 to 5.9) was strongly felt in Satsop and caused some building damage in the site area (UW 2001 and WDNR 1999).

There is increasing geologic evidence that other regional seismic sources have the potential to produce shallow continental crust earthquakes. Shallow crustal seismic events appear to be more widespread geographically relative to the other sources of historical seismicity, and often occur along mapped or postulated faults exposed at the earth's surface. Based primarily on historic and paleo-seismicity, Quaternary shallow crustal faults are considered capable of generating earthquakes greater than M6 and potentially as large as M7.0 to M7.5, such as the 1872 North Cascade event which was estimated to be a M7.3 (Noson et al. 1988). The largest instrumentally recorded shallow crustal earthquake in the region is the 1996 M5.3 Duvall earthquake, which has not been associated with a recognized Quaternary fault.

Known faults within 70 miles (113 km) of the plant site were identified in the studies conducted for the FSAR. These mapped faults, postulated faults, and lineaments are shown on Figure 3.1-8. The closest faults suspected to have been active in the late Quaternary are the Olympia fault and Doty fault, located 20 to 25 miles from the site. The Canyon River fault is the closest fault with documented Holocene age displacement and is located approximately 30 miles north of the site (Walsh et al. 1997).

Based on the magnitude and intensities reported for the moderate to large Pacific Northwest earthquakes listed in Table 3.1-1, strong ground accelerations greater than 0.2 gravity (g) are estimated to have occurred near the epicenters of these events. Peak ground accelerations (PGA) measured in Olympia during the large intraplate earthquakes in Puget Sound were 0.28g (1949), 0.20g (1965), 0.18g (2001). Larger PGA have likely been generated in western Washington during great prehistoric earthquakes inferred to have occurred on the CSZ.

The historical earthquake estimated to have generated the strongest ground motion near the proposed site was the 1949 Olympia earthquake with an epicenter about 37 miles (60 km) from the site. Peak ground accelerations (PGA) of 0.1g to 0.15g are estimated to have occurred at the site during this event based on computations developed by Crouse (1991a, 1999b) and the WPPSS (1988b). The PGA recorded near Satsop during the 2001 Nisqually earthquake was 0.08g. A value was not obtained from this station during the 1999 Satsop earthquake.

Values of PGA were also computed at the site for use in the design of the existing plant. The FSAR reports calculations of median value for PGA obtained from several published ground-motion attenuation equations. In that analysis, the postulated earthquake estimated to produce the largest ground motion at the site was a M7.5 event on the Olympia lineament at a distance of 22 miles (35 km) from the site. The resulting median PGA values computed for this event were 0.16 to 0.17g.

3.1.3 SOILS

Naturally occurring, surficial soils have been modified or removed as a result of the prior grading and construction activities at the site. The gravel-covered ground surface at the site is sparsely vegetated in the western half, while the eastern half is covered with small coniferous trees. The subsurface strata and engineering properties of the Helm Creek deposits in the site area have been assessed in conjunction with work completed for WNP-3 and Satsop CT Phase I. Site-specific conditions of the proposed Phase II project have been investigated by URS (2001). Subsurface conditions were investigated by drilling 9 borings, advancing 27 electric cone penetrometer probes, and excavating 5 test pits. The locations of these explorations are shown on Figure 3.1-9. Borings were drilled to depths of 60 to 120 feet, the cone probes were pushed to depths of 40 to 133 feet, and the test pits were excavated to depths of 10 to 12 feet.

Generally, the soils encountered at the site consisted of up to approximately 75 feet of alluvial soils interpreted as Helm Creek deposits, overlying decomposed sandstone from the Astoria Formation. Interpreted cross sections of the subsurface soils are illustrated on Figures 3.1-10 and 3.1-11. The engineering properties of these strata are summarized in Table 3.1-2. The specific description of each soil unit, proceeding downward from the ground surface, is as follows:

- <u>Gravel Surfacing</u> - The site is covered with a gravel fill approximately 1.5 to 2.5 feet in thickness. The gravel is subrounded, reasonably well graded and contains some silt and sand as well as cobbles. At the base of this fill cover is a geotextile.

- <u>Stratum 1</u> - Reddish Brown Medium Stiff to Stiff SILT

  This soil layer is typically 5 to 12 feet thick, and medium stiff to stiff in character based on N-values, cone tip resistances, pocket penetrometer test values and unconfined compression test values. Other laboratory tests indicate that this silt is moderately to highly plastic (liquid limit of 54) and moderately compressible. Moisture contents were usually in the range of 38 to 44 percent.

- <u>Stratum 2</u> - Yellowish Brown Silty SAND to Sandy SILT

  This soil layer grades between a fine sand and a silt, and typically exhibits the character of a fine-grained soil. The layer is only 4 to 10 feet thick along the western 200 feet of the site, but is typically 20 to 30 feet thick elsewhere. The soil would be characterized as stiff based on N-values and cone tip resistance values. Laboratory tests indicate that the fines content of the layer ranges from 39 to 65 percent for the samples tested. The fines appear to be non-plastic. Consolidation tests indicate that the soil is moderately compressible but drains quickly. High natural moisture contents in the range of 40 to 50 percent were measured.

TABLE 3.1-2
SUMMARY OF SOIL CONDITIONS AND DESIGN PARAMETERS

Item	Stratum 1 Silt	Recompact. Stratum 1 Silt	Stratum 2 Silty Sand Sandy Silt	Stratum 3 Gravelly Sand	Stratum 4 Silty Sand
Average Thickness (ft)	10		20	40	40+
Typical Uncorrected N-values (bpf)	2 to 5		3 to 10	14 to 35	20 to 40
Typical Cone Tip Resistance (tsf)	6 to 10		30 to 60	100 to 200	50 to 100
Ave. Shear Wave Velocity Vs (fps)	640	680	870	1,590	1,320
Ave. Compr. Wave Velocity Vp (fps)	1,560	1,700	1,800	3,300	2,750
Total Unit Weight γ (pcf)	110	110	110	130	120
Friction Angle ϕ (degrees)	0	0	0	40	36
Cohesion c (psf)	900	1,200	1,200	0	50
Dynamic Elastic Modulus Emax (ksf)	3,800	4,400	7,000	27,000	17,000
Static Elastic Modulus E (ksf)	300	3,20	250	800	600
Dynamic Shear Modulus Gmax (ksf)	1,400	1,600	2,600	10,200	6,500
Poisson's Ratio v	0.4	0.4	0.35	0.35	0.35
Active Earth Pressure Coeff Ka	0.36	0.36	0.31		
At-Rest Earth Pressure Coeff Ko	0.53	0.53	0.47		
Passive Earth Pressure Coeff Kp	2.7	2.7	3.2		
Soil-Concrete Friction Coefficient	0.3	0.3	0.3		
California Bearing Ratio CBR	5	6			
Compression Index $Cc\varepsilon$	0.1	0.1	0.08		
Coeff of Consolidation cv (ft^2/day)	1.5	1.5	8.5		
Permeability k (cm/sec)	10^{-5}	10^{-5}	10^{-3}		
Thermal Resistivity (^{o}C-cm/W)	50	50	46		

Notes:

1. The Vs values are measured (except for Recompacted Stratum 1); Vp values are estimated.
2. The Gmax and Emax values apply to a shear strain level of approximately 10^{-4} percent.
3. The $Cc\varepsilon$ Compression Index is from a percent strain versus log of applied load curve.
4. Values listed above generally represent average to the slightly conservative side of average values based on interpretation of available data. Natural variability of soil conditions and parameters are expected to occur throughout the site.
5. The water table is interpreted to be at a depth of at least 70 feet.

Source: URS 2001

- Stratum 3 - Multi-colored Medium Dense to Dense Gravelly SAND

  This layer typically consists of well-graded sand with 15 to 50 percent gravel and 15 to 25 percent fines. The apparently re-worked sediments show color variations that include red, green, gray, brown and white. This layer is at least 25 feet thick, and more typically the thickness exceeds 35 feet. N-values and cone tip resistance values suggest that the layer is medium dense to dense in character.

- Stratum 4 - Brown to Grayish Brown Silty SAND

  This layer is interpreted to be a residual soil derived from the Astoria Sandstone formation. It is primarily silty sand, but contains occasional zones that are primarily silt. N-values and cone tip resistance values suggest that the soil is dense in character. The last sample collected in boring B-3, at a depth of 111 feet bgs, appeared to be the weathered top of the Astoria sandstone.

3.1.4 TOPOGRAPHY

3.1.4.1 Existing Conditions

The proposed plant site is located in the Chehalis Lowlands section of the Willapa Hills physiographic province (Figure 3.1-1). Provinces are defined by areas which possess similar surface topography, river drainage patterns, have common subsurface geology and recent geologic history. The Chehalis Lowlands section is characterized by low rolling hills and broad river valleys flanked by river terraces, or flat narrow benches. Elevations within the Chehalis Lowlands range from 480 to 1,000 feet (150 to 300 meters).

The proposed plant site is located on a flat terrace above the Chehalis River in a region characterized by finely dissected uplands cut by the valley of the Chehalis River. The terrace lies at an elevation of approximately 305 feet (93 meters) above mean sea level (MSL), 300 feet (91 meters) above the Chehalis River. The gravel-covered ground surface slopes gently downward to the west and north, with a total topographic relief across the site of about 30 feet (Figure 3.1-9). The low point of the site is at approximately Elevation 284 at the northwest corner. From the site, elevation drops 240 feet (73 meters) to the next lower river terrace in a steep, but short slope to the north. West of the site, approximately 3,000 feet (315 meters), the terrace drops to river level in a steep river cutbank.

The land surface rises to the south of the site in a finely dissected drainage pattern to a topographic high of over 1,760 feet (536 meters) at Minot Peak, 6 miles (10 km) to the southeast. Fuller Creek, less than 1,500 feet (450 meters) southeast, is the nearest surface drainage. It flows northeast to the Chehalis River in a 100-foot (30-meter) deep valley.

3.1.4.2 Potential Impacts

The planned finished grade of the project will be approximately elevation 305 (Figures 3.1-9 through 3.1-11). Therefore construction of Phase II will require some cutting and filling that will have an insignificant impact on topography. The amount of material to be removed and replaced, as described in Subsection 2.3.3.2, is 80,000 cubic yards.

3.1.4.3 Mitigation Measures

No mitigation measures are necessary.

3.1.5 UNIQUE PHYSICAL FEATURES

There are no unusual or unique geological or physical features in the project area that could potentially be affected by the project.

3.1.6 EROSION/ENLARGEMENT OF LAND AREA (ACCRETION)

3.1.6.1 Existing Conditions

As part of the soil surveys of Grays Harbor County, the State of Washington Department of Natural Resources (DNR) conducted a survey that evaluated the erosion potential in an area that includes the proposed plant site. The rating for erosion potential is based on the interaction of the following conditions:

- Soil properties, including texture, structure, and porosity
- Rainfall rate and storm intensity
- Slope

The soil property is represented in the commonly used Universal Soil Loss Equation as the K factor. The K factor and slope conditions of the project are further evaluated in other sections of this report in an effort to more specifically characterize the separate parts of the project. In summary, the larger the K factor of a soil, the higher the potential for erosion, given that all other factors remain constant.

Rainfall rate is readily available from government agencies and slope is a function of the rise in elevation over a horizontal distance expressed as a percentage. Slopes greater than 15 percent are classified as having high potential for erosion, slopes from 5 to 15 percent have medium potential, and less than 5 percent have a low potential.

The evaluation is summarized on Figure 3.1-12 by classifying the areas into three categories to qualitatively describe the erosion potential. The categories are low, medium, and high erosion potential. In areas with the low designation the potential for erosion is insignificant. In areas with the medium designation, the potential for erosion is significant and extensive erosion can occasionally occur, but can be reduced or limited by avoiding unnecessary surface disturbance. In areas with the high designation, erosion can frequently be expected to occur on all bare surfaces.

The soils underlying the proposed plant site and in the immediate vicinity of the site have been assigned K factors of between 0.15 to 0.32 at the depths expected to be disturbed during construction (Soil Conservation Service, no date). These values correspond to a high potential for soil erosion. The slope at the plant site itself has a rating of 1 (low); slopes adjacent to Fuller Creek to the east have a slope rating of 3 (high). It is anticipated that the majority of disturbance during the plant construction and operation will occur on the relatively flat bench away from the creek. Table 3.1-3 presents a slope rating system that was established to quantitatively describe the terrain features in the site area.

TABLE 3.1-3
SLOPE RATING SYSTEM

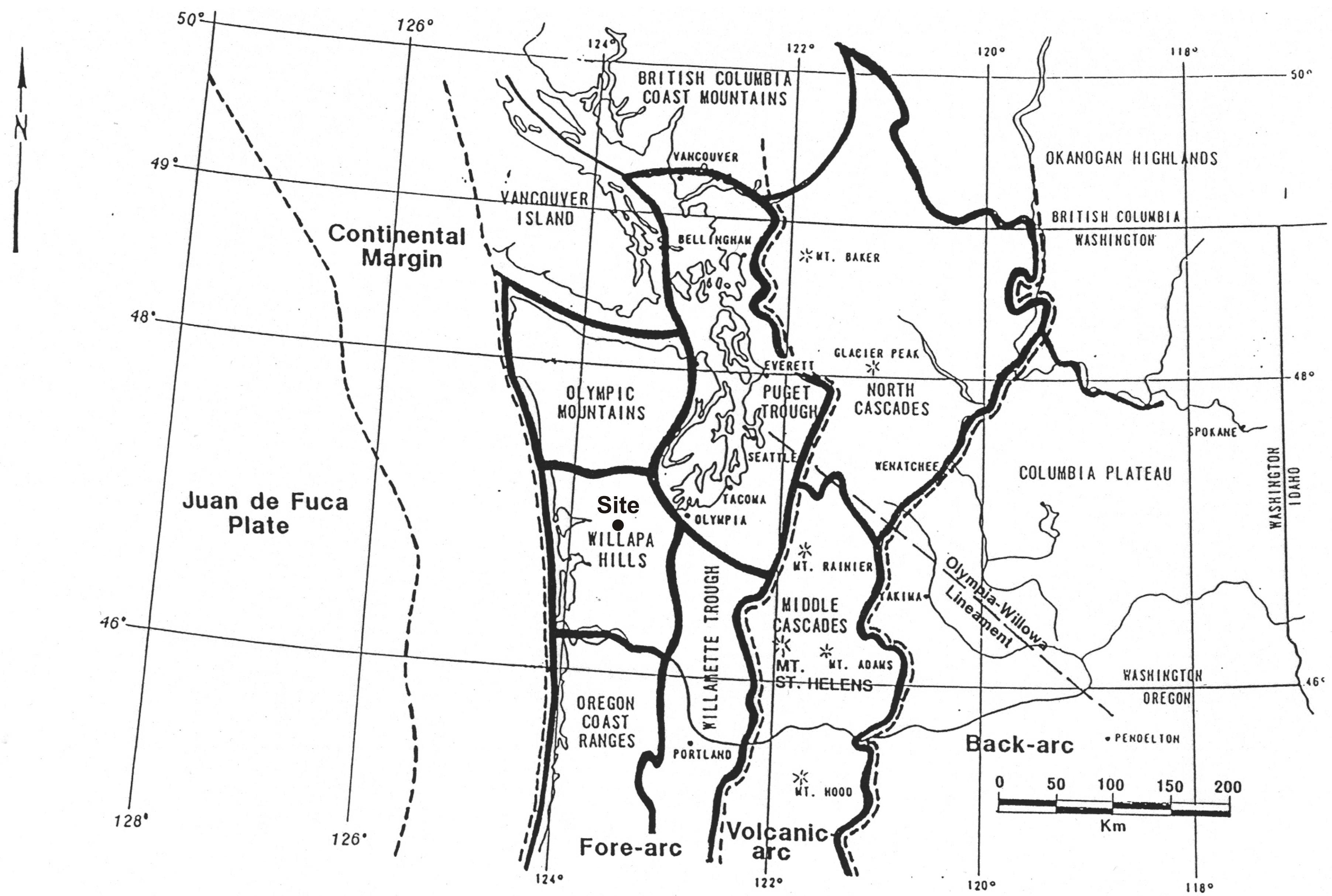
Slope Rating	Description	Slope Range (percent)
1	Low	0-5
2	Moderate	5-15
3	High	greater than 15

3.1.6.2 Potential Impacts

The Certificate Holder has an EFSEC-approved Erosion Control and Sedimentation Plan for the Phase I project which covers the entire site, including the area proposed for Phase II project. This plan is applicable to Phase II and is designed to prevent and/or minimize the potential for erosion. See Environmental Commitments Book, August 2001 for a description of the approved measures. Implementation of the plan will result in minimal if any erosion impacts.

3.1.6.3 Mitigation Measures

No additional mitigation measures are warranted beyond proper implementation of the EFSEC-approved Erosion Control and Sedimentation Plan.



LEGEND:

Tectonic Terrane

Tectonic Province

Geo-Political Boundary

Source: Fugro Northwest, Inc., 1979 and McCrumb and others, 1989.

Figure 3.1-1

Tectonic Terranes and Province of the Pacific Northwest

URS

Phase II Expansion
Satsop CT Project

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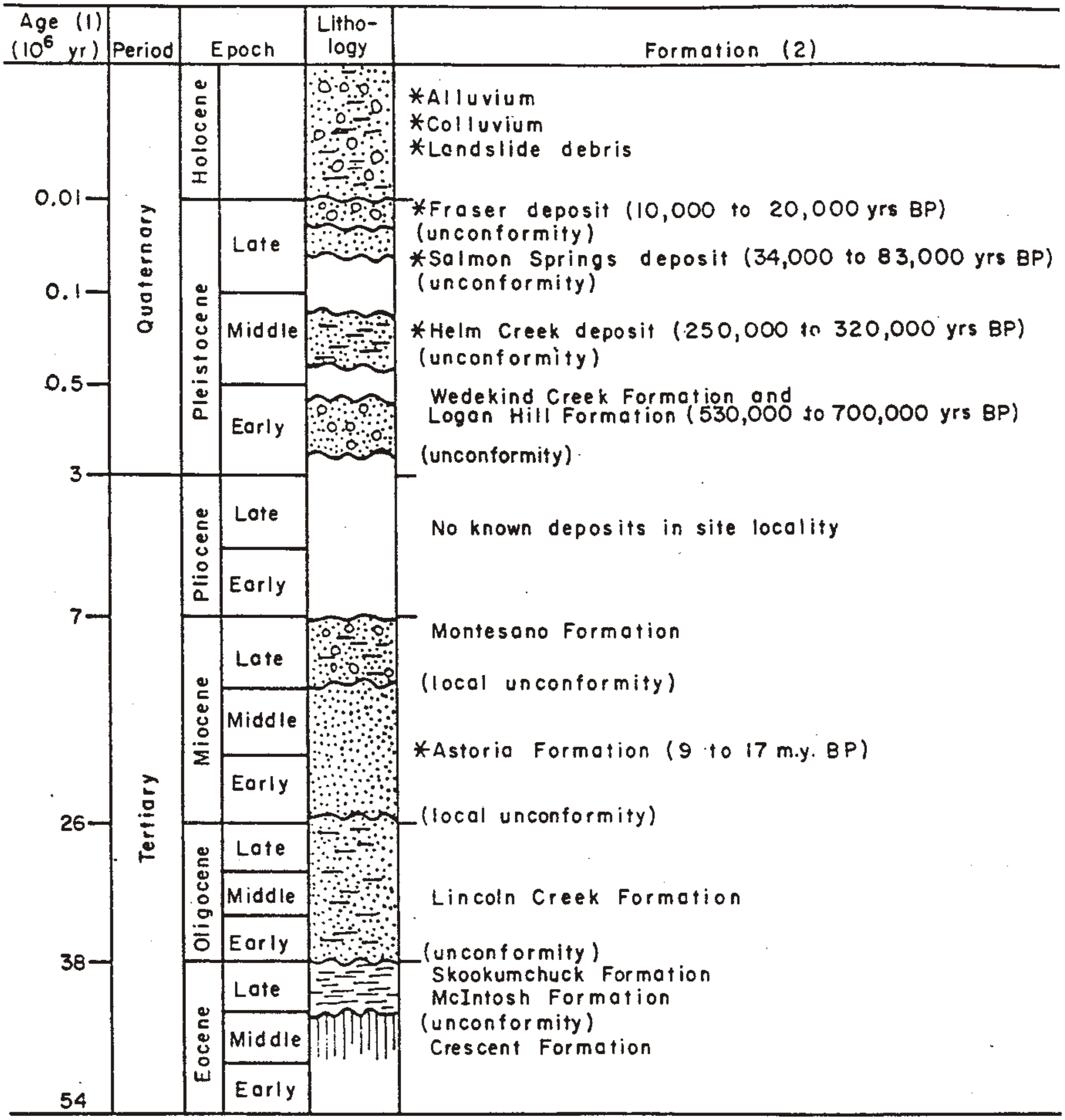
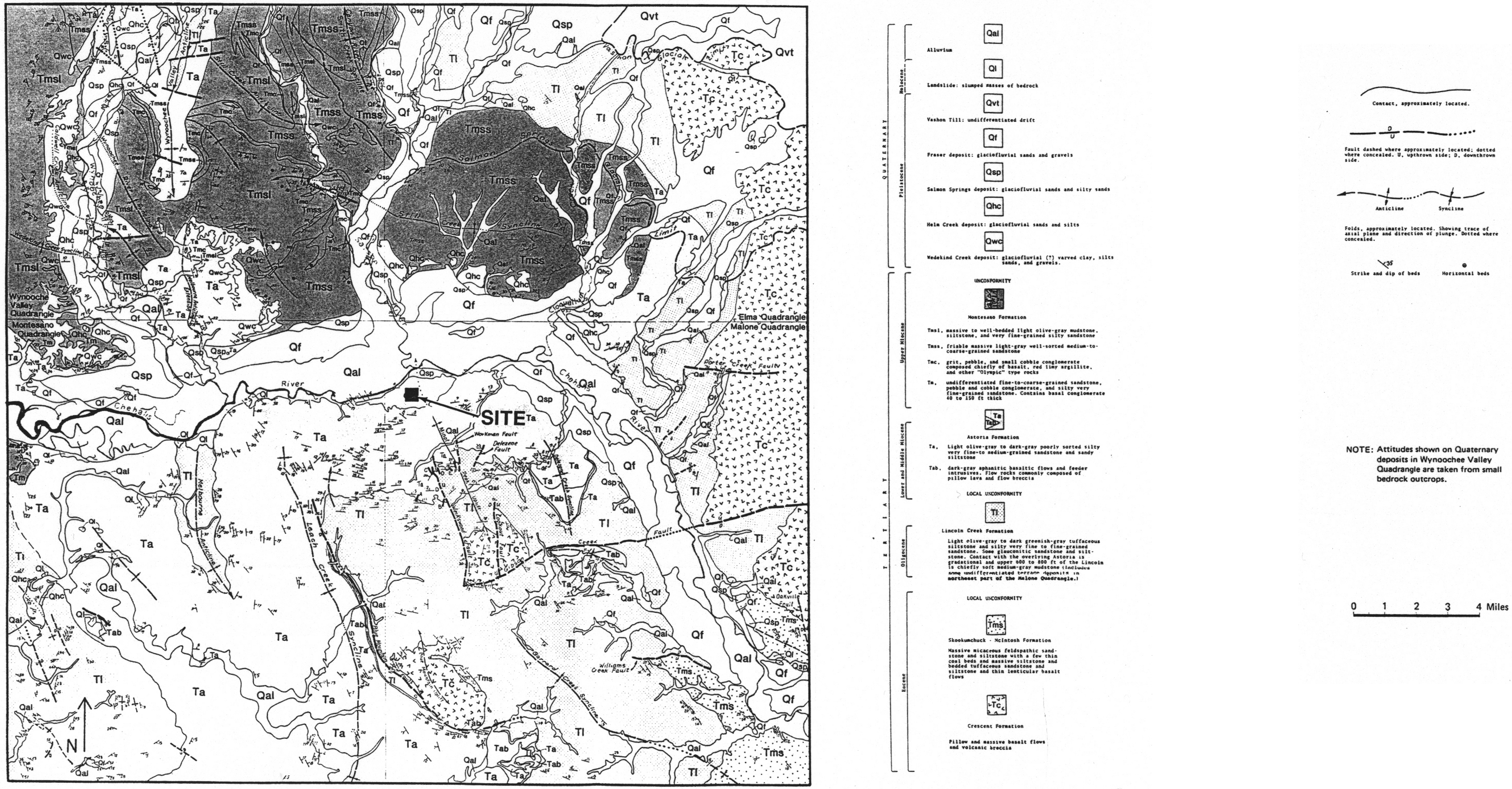


*Formations present within 1.5 mi of plant location

Source: Washington Public Power Supply System, Nuclear Projects 3 & 5, Final Safety Analysis Report.

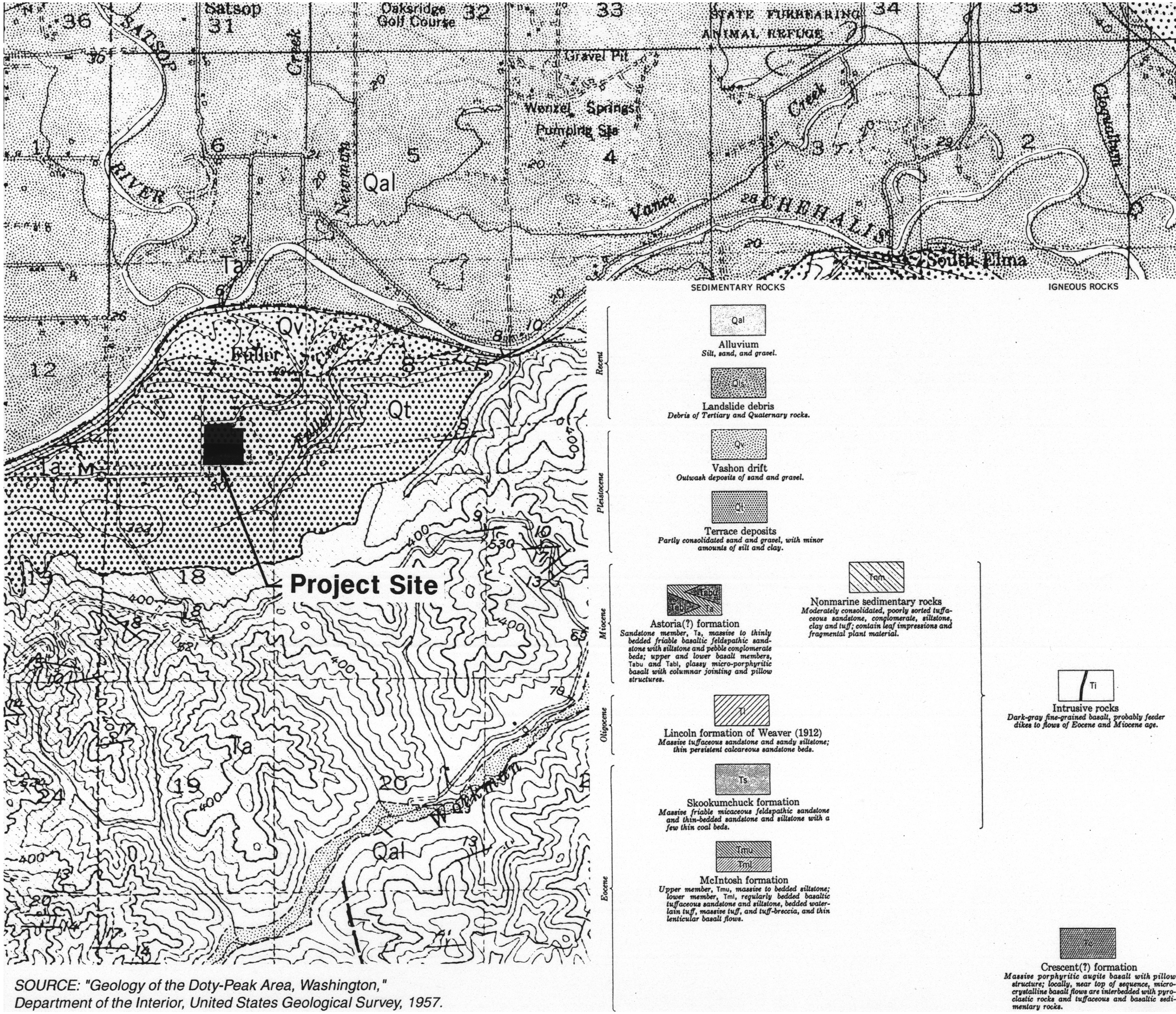
Figure 3.1-2
Local Stratigraphic Column

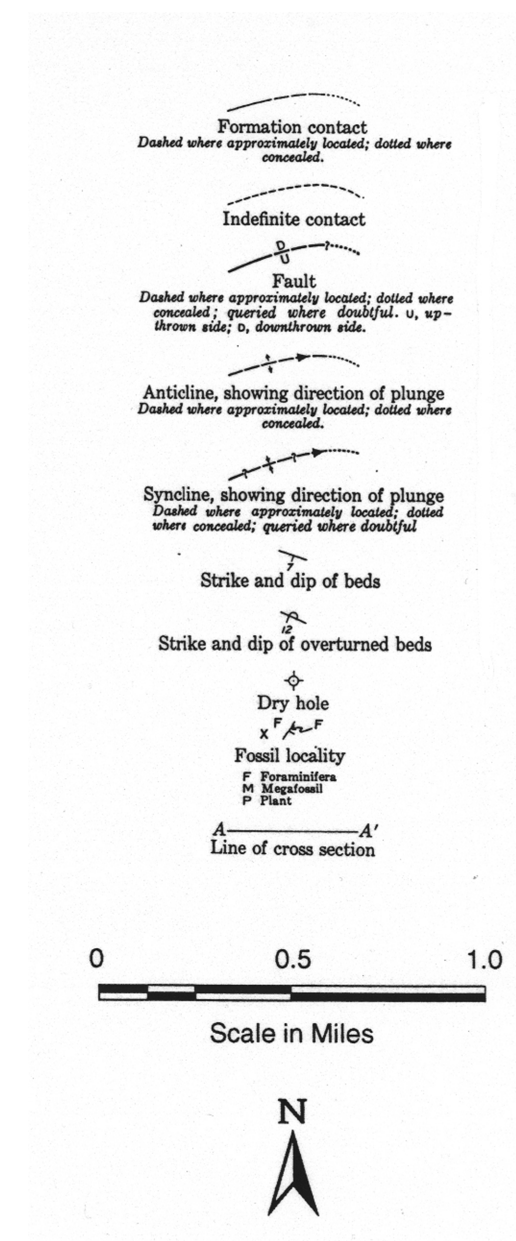


Source: Washington Public Power Supply System, Nuclear Projects 3 & 5, Final Safety Analysis Report.

Figure 3.1-3
Regional Geology and Structure Map

46866002.01_29.cdr





SOURCE: "Geology of the Doty-Peak Area, Washington," Department of the Interior, United States Geological Survey, 1957.

Figure 3.1-4
Site Geology Map

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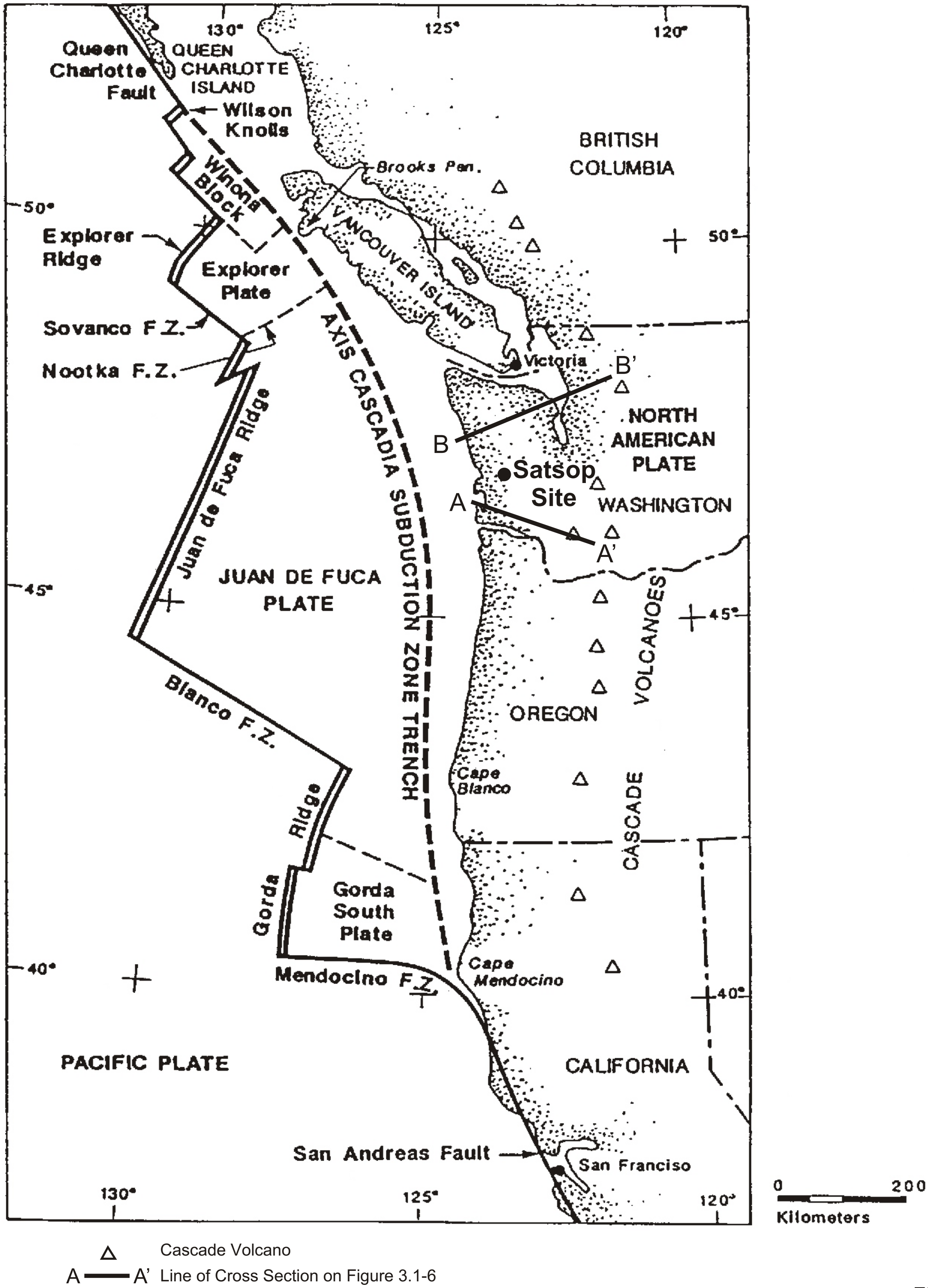
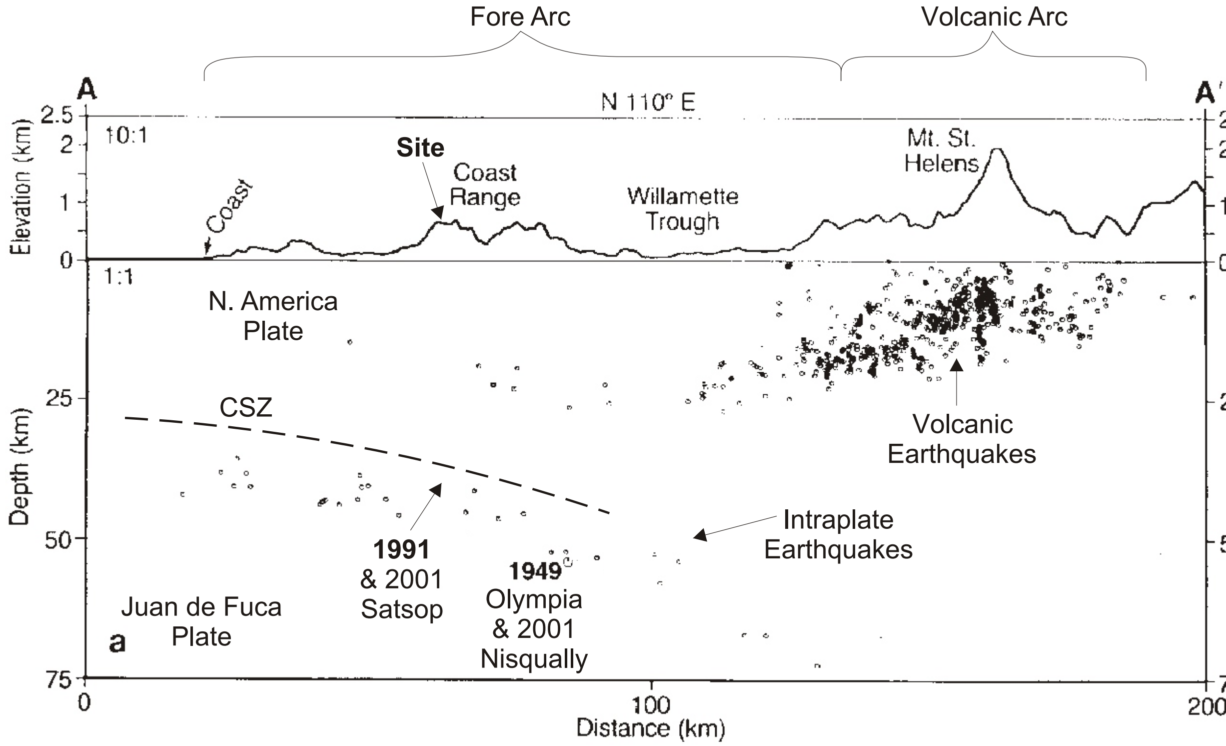
46866002.01_17.cdr



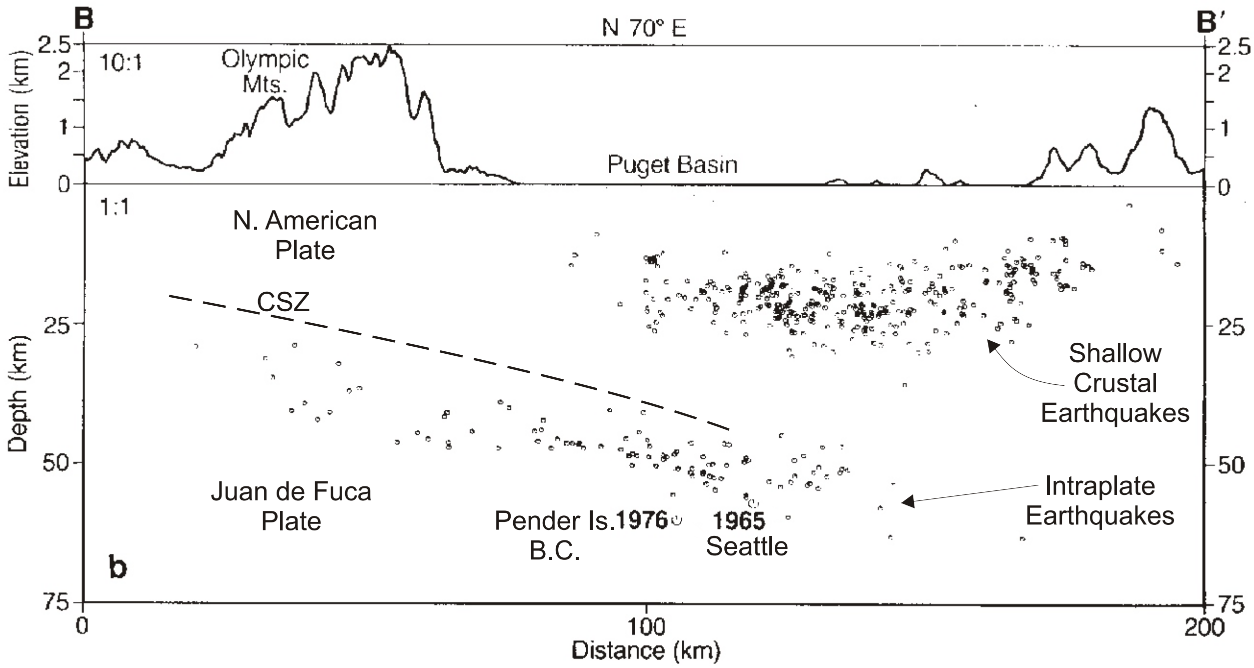
Modified from Washington Public Power Supply System (1988)
(after Riddihough, 1984).

Figure 3.1-5

Tectonic Setting of the Cascadia Subduction Zone



a. Southwestern Washington Cross Section A-A'



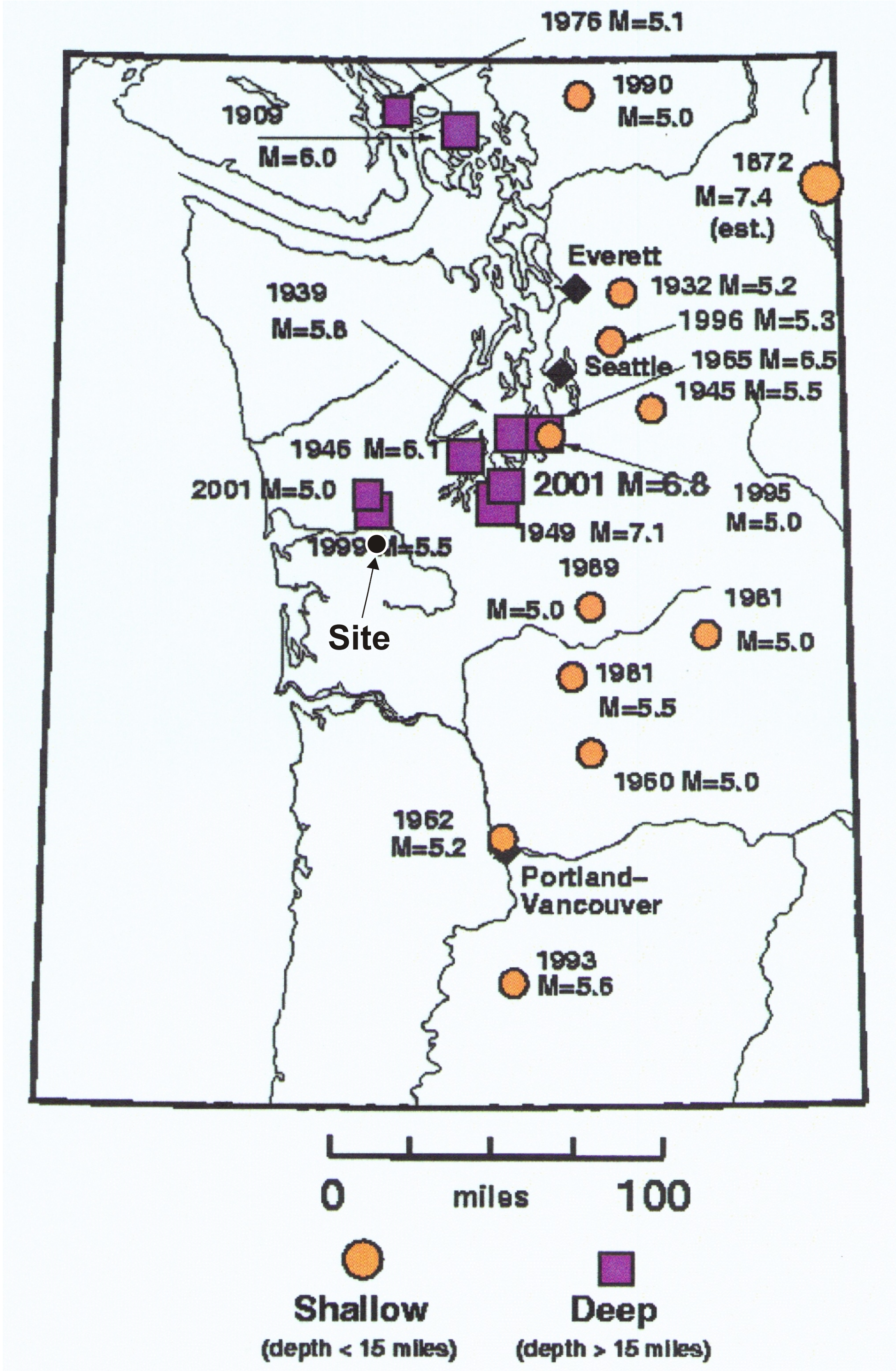
b. Northwestern Washington Cross Section B-B'

CSZ = Cascadia Subduction Zone

See Figure 3.1-5 for cross section locations.

Figure 3.1-6

Cross Sections of Earthquake Hypocenters Beneath Western Washington

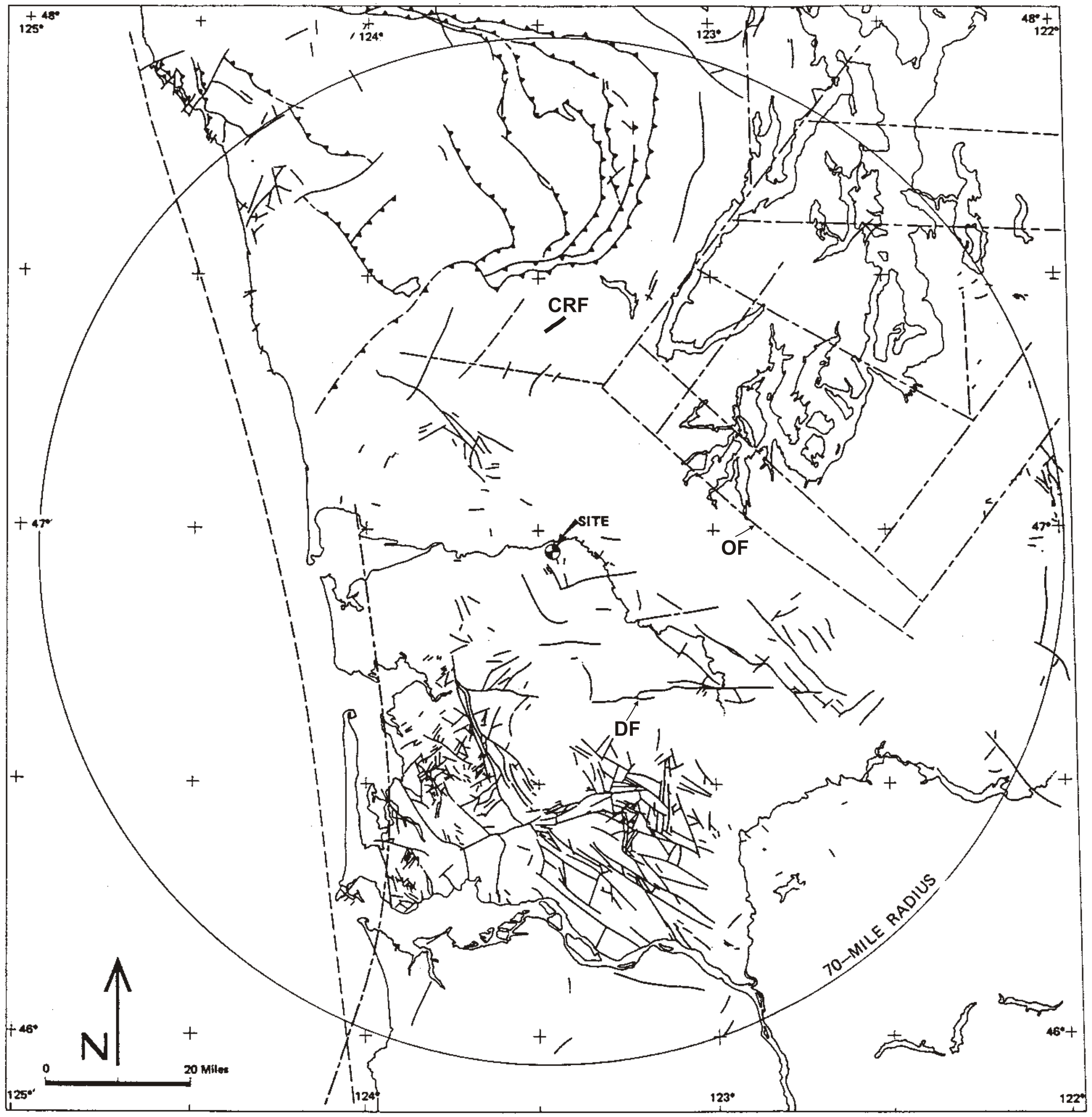


Source: University of Washington

Figure 3.1-7

Epicenters and Dates of Larger Pacific Northwest Earthquakes

46866002.01_31.cdr



EXPLANATION

KNOWN FAULTS:
High Angle
Thrust (barbs indicate upper plate)

POSTULATED FAULTS:
Based on minimal evidence

PUBLISHED LINEAMENTS:
Based mainly on geophysical and physiographical evidence

CRF Canyon River Fault

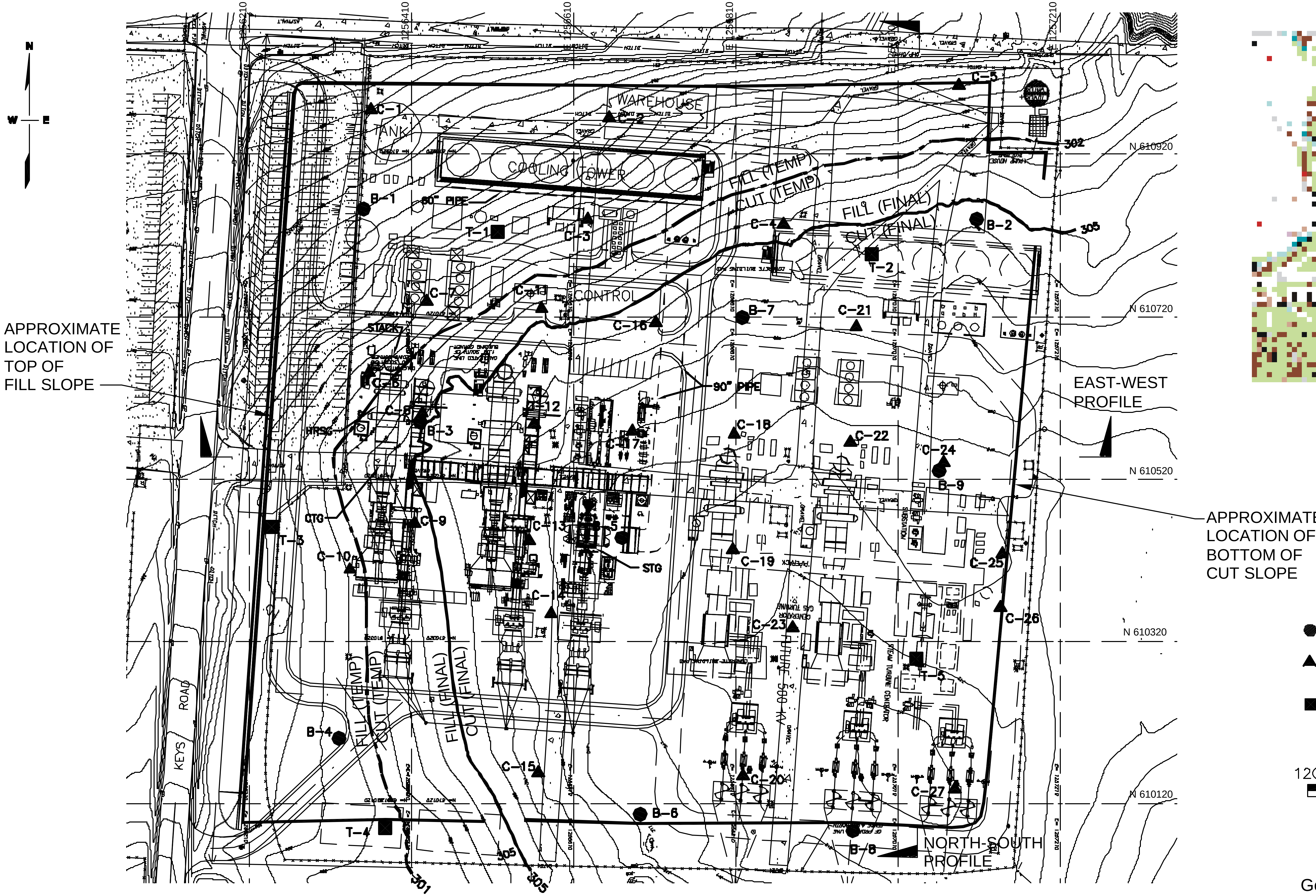
OF Olympia Fault

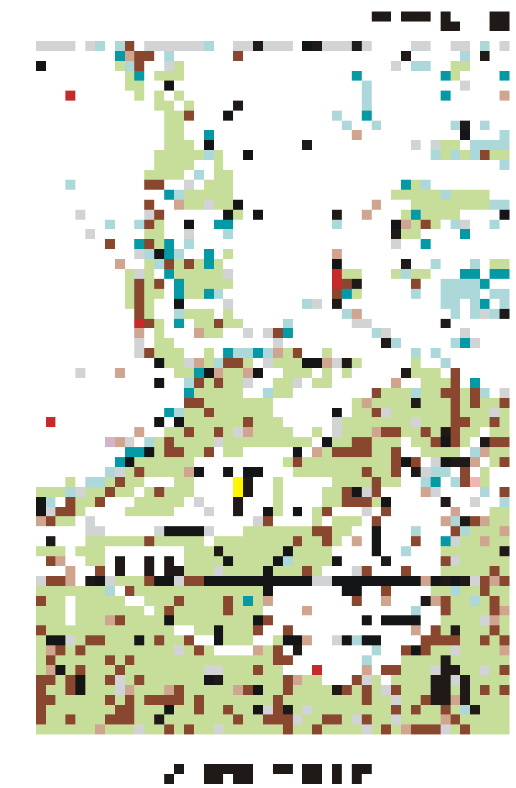
DF Doty Fault

Source: Washington Public Power Supply System, Nuclear Projects 3 & 5, Final Safety Analysis Report.

Figure 3.1-8

Known Faults, Postulated Faults, and Published Lineaments Within 70 Miles of Site





LEGEND

B-2	BORING LOCATION
C-21	ELECTRIC CONE PENETROMETER PROBE
T-2	TEST PIT

SOURCE: URS, 2000

120 60 0 120

SCALE: 1"=120'

Figure 3.1-9
Geotechnical Boring Locations
And Site Plan

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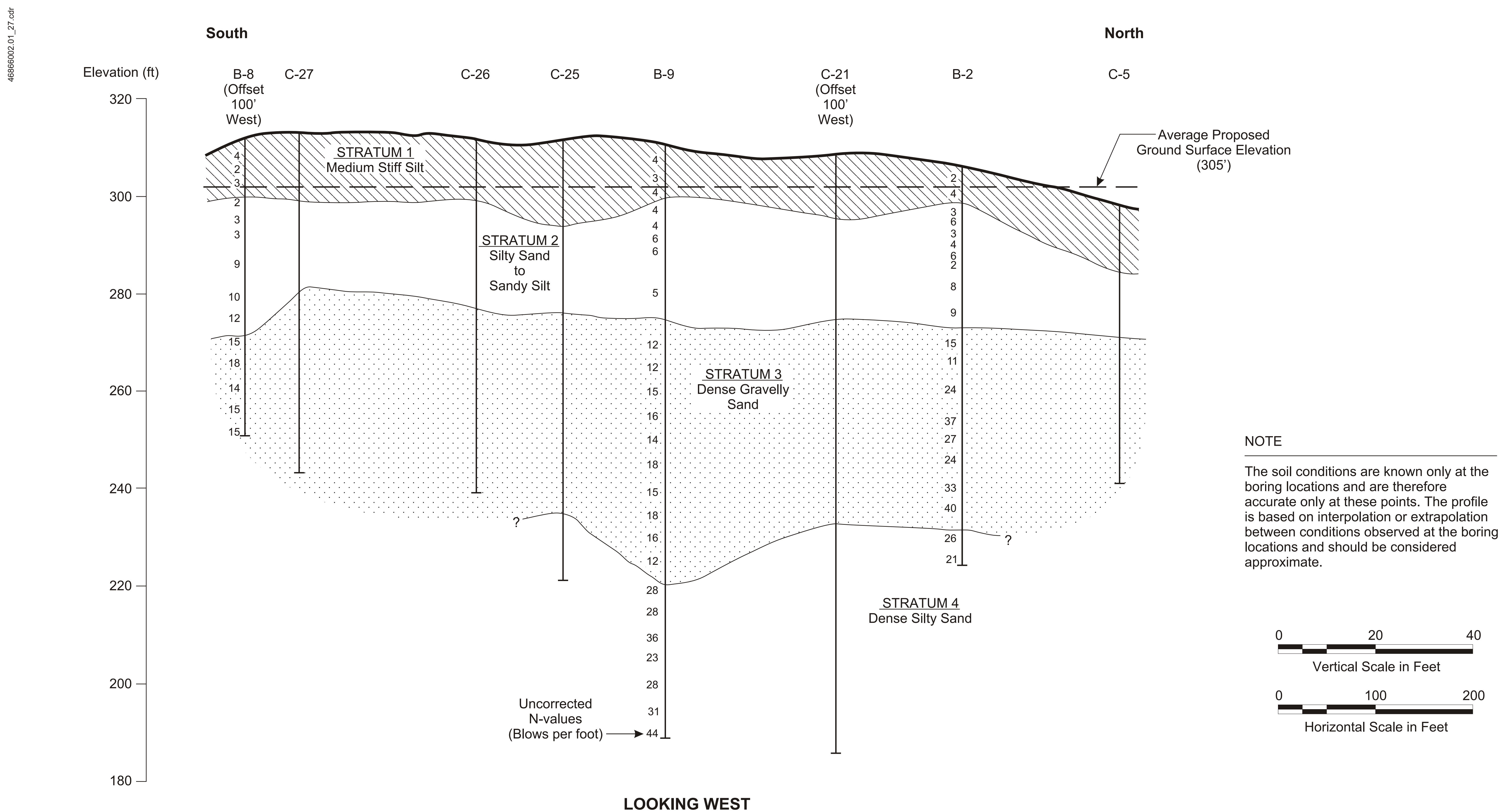

Source: URS 2001

Figure 3.1-10
East-West Cross Section

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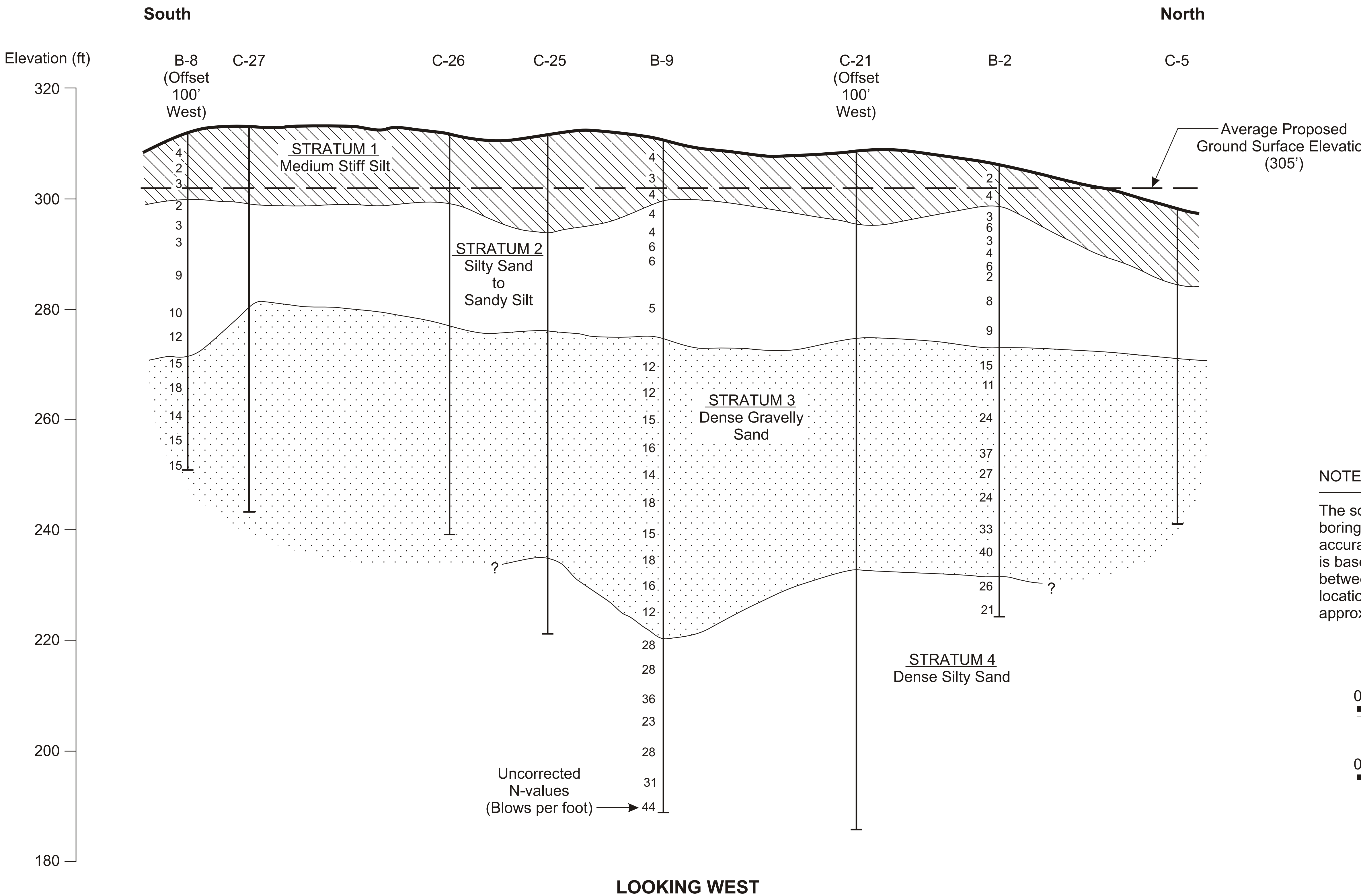

NOTE

The soil conditions are known only at the boring locations and are therefore accurate only at these points. The profile is based on interpolation or extrapolation between conditions observed at the boring locations and should be considered approximate.

0 20 40

Vertical Scale in Feet

0 100 200

Horizontal Scale in Feet

Source: URS 2001

Figure 3.1-11

North-South Cross Section

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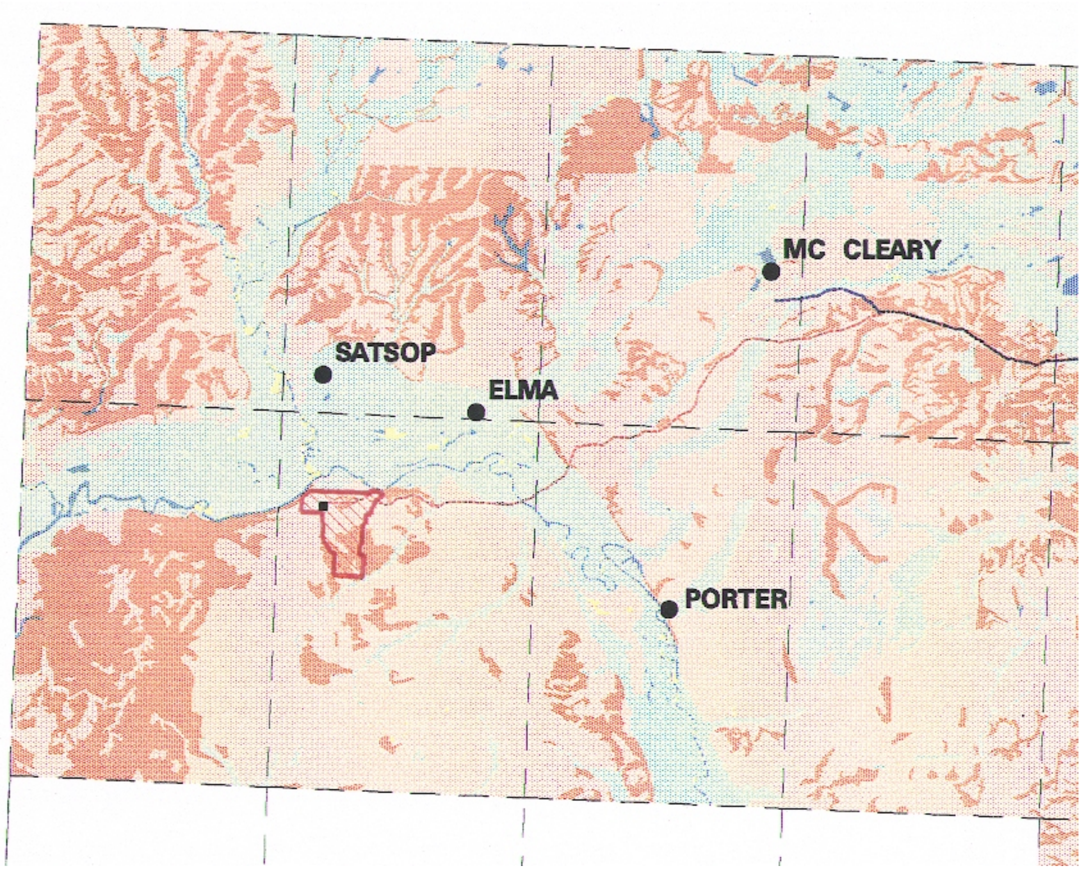
46866002.01_35.cdr



LEGEND:

Existing Gas Pipeline

Property Boundary

Project Site

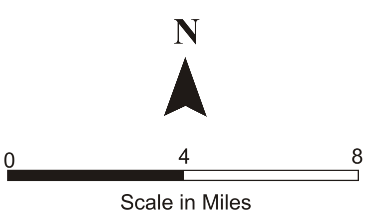
Water/Wet

Low

Medium

High

Variable



Source: Washington State DNR GIS (1990).

Figure 3.1-12
Erosion Potential

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